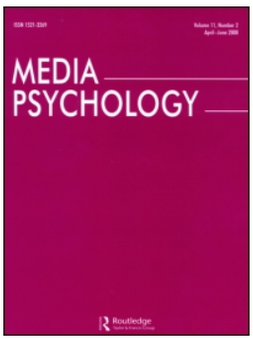

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The Role Behavioral of Activation and Inhibition in Explaining Adolescents' Game Use and Game Engagement Levels

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*According to Gray's reinforcement sensitivity theory, variations in the functioning of two neuropsychological systems, the behavioral approach (BAS) and inhibition (BIS) system, can result in individual differences in personality. Several studies have looked at associations between personality and media use but media research integrating BAS and BIS is scarce. The current cross-sectional survey study (*n = *1016) representative for Belgian adolescents investigated associations between BAS and BIS and game use and game*

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engagement in adolescents. Results showed that BAS was positively associated with playing both violent and nonviolent games. BIS was negatively associated with violent game use while it was positively associated with nonviolent games. Also, BAS was positively associated with game engagement. No association was found between BIS and game engagement. Game engagement was shown to mediate the relationship between BAS and playing both violent and nonviolent games. Based on these results, the present study argues that integrating the reinforcement sensitivity theory in media research makes an important contribution to the understanding of the link between personality and game engagement and game use.

Video games are played by millions of people around the world and can be considered one of the most popular forms of pastime, in particular, among adolescents (Griffiths, Davies, & Chappell, 2004; Jansz & Martens, 2005). This popularity is evidenced by the large amount of time young people spent, with playing games. Belgian adolescents between the ages of 13 and 17 spent, on average, 1 hour and 7 minutes on gaming on a school day and 2 hours and 16 minutes on a day during the weekend or a holiday (Klein et al., 2014). A wide variety of game genres, from violent games such as first person shooter games and fighting games to nonviolent games such as puzzle and platform games, has been shown to be appealing to adolescents (Klein et al., 2014).

Drawing from the uses and gratifications theory (UGT; Katz, Blumler, & Gurevitch, 1973; McQuail, 2000), it can be assumed that personality characteristics are important determinants of the choice for a certain game and of the extent to which someone gets engaged in the game during game play. Previous studies investigating the association between personality and game use have primarily operationalized personality in terms of the five-factor model of personality (i.e., openness, conscientiousness, extraversion, agreeableness, and neuroticism; Costa & McCrae, 1992; Goldberg, 1992) or the biologically based theory of Eysenck (1963; i.e., psychoticism, extraversion, and neuroticism), or they have looked at distinct personality traits such as sensation seeking and aggressiveness (Arriga & Esteves, 2006; Gentile, Lynch, Linder, & Walsch, 2004). Although these studies confirm that personality serves as an important determinant of game use by explaining the use and consequences of different types of games, studies focusing on game use and game engagement operationalizing personality from the perspective of the reinforcement sensitivity theory (RST) of Gray (1970) are extremely scarce. This theory can, however, provide important new insights regarding the relationship between personality and media use, in addition to other categorizations of personality, given that its theoretical basis addresses the neural, biological, and psychological processes that underlie personality dimensions (Corr, 2008).

REINFORCEMENT SENSITIVITY THEORY

Over the years, several descriptive measurement models have been developed in view of identifying personality dimensions; examples are the analytical psychology based on the philosophy of Carl Jung (1960) and factor analyses of psychological adjectives (John & Srivastava, 1999; Smillie, Pickering, & Jackson, 2006). The descriptive model resulting from these approaches was a next step either considered to be the final model (e.g. Big Five framework; Goldberg, 1992) or was further investigated by identifying the underlying causes of individual differences in personality characteristics (e.g., Eysenck, 1963). The RST of Gray (1970) is an exception to these approaches by its focus on the neuropsychology of emotion, motivation, and learning (Smillie et al., 2006) and has several important advantages compared to other personality models. First of all, the RST describes the basis of personality by proposing the functioning of brain-behavioral systems that might play a role in observed variations in human behavior (Corr, 2008). One of the most important contributions of the RST approach is, therefore, its focus on the biological basis of personality by regarding the functioning of and variations in brain systems as the main source of personality differences (Corr, 2008; Revelle, 2008). Second, due to this neuropsychological approach, the RST proposes a very nuanced perspective on personality and its dimensions (Wilt, Condon, Brown-Riddell, & Revelle, 2012) in which the fundamental aspects of behavior and the core elements of emotion and motivation are described (Corr, 2008). Third, several validated scales have been developed to measure the RST concepts which are all easy to assess in child, adolescent, and adult samples (Carver & White, 1994; Franken, Muris, & Rassin, 2005; Muris, Meesters, de Kanter, & Timmerman, 2005).

According to the RST, behavior stems from the complex interplay of individual differences in the activity and reactivity of two neuropsychological systems: the behavioral approach system (BAS) and the behavioral inhibition system (BIS). Variations in the functioning of BAS and BIS are hypothesized to be responsible for individual differences in behavior. BAS is related to "reward sensitivity" (e.g. Corr, 2008; Gray, 1970) given that it is a mediator of the sensitivity to rewarding stimuli and is activated each time a rewarding cue is presented. The system, therefore, has a large influence on the initiation of approach behavior (Corr, 2008). Activation of BAS motivates individuals' behavior toward rewarding goals and stimuli. BAS is (at least partially) located within striatal and frontal brain regions, which are strongly innervated with dopaminergic projections (Pickering & Gray, 1999). Therefore, the functioning of BAS is hypothesized to be determined in part by variations in the transmission of the neurotransmitter dopamine through mesolimbic and mesocortical pathways that are located in the ventral tegmental area of the midbrain, the

nucleus accumbens, and the frontal cortex (Pickering & Gray, 1999; Wang et al., 2001).

BIS, on the other hand, is related to "punishment sensitivity" (Loxton & Dawe, 2001; Potts, George, Martin, & Barratt, 2006). This defensive system constitutes sensitivity to aversive stimuli such as signals of punishment, threat, and novelty (Corr, 2008). Behavior that might lead to negative or painful outcomes is inhibited by the activation of BIS (Carver & White, 1994). BIS is associated with septohippocampal brain structures (Gray & McNaughton, 2003) of which the main function is to detect potential threats and expectancy violations (Amodio, Master, Yee, & Taylor, 2008). Individuals with a strong BIS will, therefore, experience higher anxiety levels than others (Fowles, 1987; Vervoort et al., 2010). These people are more likely to be aware of risky situations by scanning the environment for possible dangerous situations and stimuli compared to individuals with a lower BIS sensitivity (Gray & McNaughton, 2003). BAS and BIS are theorized to be independent in the sense that the sensitivity of one system does not influence the sensitivity of the other. Nevertheless, if both systems are activated concurrently, the behavior resulting from this activation will be generated by an interaction between BAS and BIS (Corr & McNaughton, 2008)

For a long time, no consensus was reached on how to measure manifestations of these neuropsychological systems. Researchers used scales that were originally designed to measure personality traits related to BAS and BIS such as the extraversion and neuroticism scale (Eysenck & Eysenck, 1975) or the tridimensional personality questionnaire (TPQ; Cloninger, 1987). As a response to this lack of consensus, Carver and White (1994) developed a self-report measure appropriate to assess the functioning and sensitivity of both BAS and BIS in survey research, which has become a widespread and frequently used instrument in psychological literature (Franken et al., 2005; Jorm et al., 1999; Vervoort et al., 2014). However, in survey research on the topic of media use and preferences, this self-report measure of RST concepts has been rarely used. The present study aims to add to the literature by examining these concepts in research on video game use and effects.

INDIVIDUAL DIFFERENCES REGARDING MEDIA USE

Scholars have recently stressed the need to conduct more research on the associations between media variables and non-media variables, such as personality traits, in order to improve our understanding of media use and its effects (Valkenburg & Peter, 2013). The UGT (Katz et al., 1973; McQuail, 2000) is one of the most cited theories in explaining the link between personality and media use. The theory describes why people use certain media and why different people develop different media preferences. The UGT regards

members of the audience as active individuals who use media in a goal-directed way: They select a certain medium or content based on the degree to which it has the ability to satisfy their needs. These gratifications sought by the audience result, at least partially from psychological dispositions like personality traits (Katz et al., 1973). Therefore, personality traits are considered as "self-evident" factors in explaining an individuals' media use within the uses and gratification framework (Rosengren, 1974, p. 273).

Following this perspective, a limited number of studies has investigated associations between personality and media use like playing video games. These studies showed, for instance, that online game players are more open, conscientious, and extraverted compared to non-gamers, while no differences were found for being agreeable and neurotic (Teng, 2008). Regarding violent games specifically, it was found that individuals that are more open, neurotic, and extraverted but less agreeable tend to play games with a violent character more frequently compared to other, nonviolent, types of games (Chory & Goodboy, 2011). Furthermore, sensation seeking predicts the use of violent media genres such as action films, shooter games, and violence-orientated websites (Slater, 2003). In their meta-analysis, Hoffner and Levine (2005) confirmed that those higher in sensation seeking reported more enjoyment of media content containing fright and violence. Additionally, experimental research indicated that the reactions elicited by a certain game vary according to individuals' personality. High sensation seekers got more engaged while playing a violent shooter game, while the opposite was true during nonviolent game play (Ravaja et al., 2004). However, none of these studies operationalized personality in terms of BAS and BIS to explain the use of violent and nonviolent games.

THE LINK BETWEEN RST AND GAME USE

Survey research examining BAS and BIS as predictors of media use is rather limited. A study among early adolescents did show that BAS is positively related to the viewing of violent movies (Aluja-Fabregat & Torrubia-Beltri, 1998). Additionally, research on the topic of Internet addiction found that BAS is positively related to this type of internet misuse (Park et al., 2013; Yen et al., 2012). Regarding gaming, in particular, no survey studies have examined BAS and BIS as predictors of violent and nonviolent game use. One study did report a negative association between BIS and using a computer for game purposes (Giles & Price, 2008). Other studies found indications for an association between RST-related concepts and game use. Lang's Limited Capacity of Motivated Message Processing (LC4MP; Lang, Sanders-Jackson, Wang, & Rubenking, 2013; Lang, 2000) describes an appetitive and defensive system, which seem closely related to BAS and BIS given their comparable emphasis on an appetitive or approach system and a defensive or inhibition system. The

BAS-like appetitive system is associated with interest in arousing game genres that tend to be violent or competitive, such as fight games, sports games, and war games. The BIS-like defensive system, on the other hand, is linked in a positive way with interest in nonviolent game genres such as puzzle games and classic games. Negative associations were found between this defensive system and massively multiplayer online role-playing games (MMORPG), which might be attributed to their violent character (Potter, Lee, & Rubenking, 2011). Different from focusing on specific game genres, several studies investigated game use and its effects in a more general way, simply by making the distinction between violent and nonviolent games (Graybill, Strawniak, Hunter, & O'Leary, 1987; Persky & Blascovich, 2007). The present study follows this general approach by linking BAS and BIS to both violent and nonviolent game use.

In addition to evidence based on self-reports, several brain scan studies have provided some neurological insights on the possible nature of the relationship between BAS and game use. To the best of our knowledge no brain studies have investigated the link between BIS and game use. Several studies found associations between game use and dopamine release. A study using positron emission tomography scans, for instance, showed that the dopaminergic reward system, by which BAS is driven, is activated during game play (Koepp et al., 1998). Additional support for this result was found in studies using functional magnetic resonance imaging scans, showing that striatal reward related brain areas are activated while playing a gambling game (Reuter et al., 2005), a nonviolent game (Hoeft, Watson, Kesler, Bettinger, & Reiss, 2008), and a first-person shooter game (Kätsyri, Hari, Ravaja, & Nummenmaa, 2013). Also, Mathiak et al. (2011) found striatal dopamine release during a first person shooter game but found no support to contribute this release to the occurrence of violent events in the game. These results show that playing violent as well as nonviolent games is associated with an activation of reward regions in the brain. Therefore, it can be proposed that merely the presence of violence in a game does not suffice to explain why individuals are attracted to a game. The level of competition in a game, for instance, might also play an important role in the extent to which a game, violent or nonviolent, is rewarding for the players. Research already showed that the presence of competition in a game had a larger influence on aggressive behavior than the violent character of a game (Adachi & Willoughby, 2011), providing evidence for the importance of taking into account this characteristic of games in research on the topic.

Rewarding cues in games have also been shown to be associated with an increase in propensity to continue game play (Chumbley & Griffiths, 2006). These results are consistent with the activating function of the BAS. Combining the functioning of BAS with the proposition of the UGT (McQuail, 2000) that states that people select a media content based on its ability to satisfy their needs and the assumption that video games in general are fun and enjoyable

(King, Delfabbro, & Griffiths, 2009), the present study assumes that both violent and nonviolent game genres can provide an appetitive, rewarding stimulus making them both attractive genres for individuals with a sensitive BAS.

H1:Behavioral activation (BAS) is positively correlated with playing violent games.
H2:Behavioral activation (BAS) is positively correlated with playing nonviolent games.

The BIS, on the other hand, is sensitive for signals of punishment, fear, and threat which can lead to avoidance behavior regarding situations in which this type of signal is often encountered (Corr, 2008). Violent, aggressive games have been shown to induce feelings of anxiety (Anderson & Ford, 1986; Baldaro et al., 2004) and hostility (Anderson & Ford, 1986; Arriaga & Esteves, 2006). For that reason, we assume that BIS is negatively associated with violent gaming. On the other hand, in line with the findings of Potter et al. (2011), a positive relationship is expected between BIS and nonviolent games that are less likely to provide anxiety-related stimuli and are more tame in nature making them more attractive for individuals with higher BIS scores compared to violent games.

H3:BIS is negatively correlated with playing violent games.
H4:BIS is positively correlated with playing nonviolent games.

GAME ENGAGEMENT

Although games often differ in game design, story lines, and appearance, they have one important thing in common: They provide a distraction from everyday life by drawing people into the world of the game (Jennett et al., 2008). This subjective experience has been labeled with a wide variety of constructs (Boyle, Connolly, Hainey, & Boyle, 2012; Procci, James, & Bowers, 2013) such as immersion (Brown & Cairns, 2004), presence (Wirth et al., 2007), and flow (Csikszentmihalyi, 1988; Jegers, 2007). Immersion can be described as a state in which gamers are engaged in the game but are still aware of the real-world surroundings (Banos et al., 2004). Almost all game players experience some level of immersion (Brockmyer et al., 2009). Presence can be defined as a "state facilitated by feelings of empathy and atmosphere, which links immersion to factors of graphics, plot, and sounds in addition to emergent gameplay" (Nacke & Lindley, 2008, p. 81), making users feel personally and physically present in the environment being displayed (Wirth et al., 2007). The concept of flow was introduced by Csikszentmihalyi (1988) in view of explaining the characteristics

of an optimal human experience and has been applied to a variety of domains such as game use. A state of flow can be described as "a dynamic equilibrium between skills and challenges which can be achieved in an intrinsic rewarding activity such as game play" (Nakamura & Csikszentmihalyi, 2002, p. 90).

Brockmyer et al. (2009) attempted to combine some of these dimensions by developing a measure that represents the aspects most commonly referred to and labelled this construct "game engagement." Immersion is defined as the lowest level of engagement followed by presence, flow and the highest level of engagement: absorption. The game engagement concept shows some important intersections with the transportation theory of Green and Brock (2000). According to this theoretical perspective, transportation occurs on a physical and/or psychological level when an individual "loses access to some real-world facts in favor of accepting the narrative world that the author has created" (Green & Brock, 2000, p. 702). Related concepts such as transportation, presence, and flow have been shown to be strongly associated with enjoyment (Green, Brock, & Kaufman, 2004; Weibel, Wissmath, Habegger, Steiner, & Groner, 2008). Higher engagement levels are associated with more willingness to use a certain game again in the future (Green et al., 2004). In that sense, game engagement can be hypothesized to be an important determinant of game use and game preferences. Several studies have stressed the importance of investigating associations between personality traits and media engagement given that not every individual will be just as likely to become engaged to the same extent during media use (Green et al., 2004; Lombard & Ditton, 2006; Wirth et al., 2007). Nevertheless, to date, little is known about the role of personality traits as a possible determinant of game engagement. Regarding media use in general, Weibel, Wissmath, and Mast (2010) did show that individuals scoring high on the Big Five dimensions of openness to experience, extraversion, and neuroticism are more susceptible to getting engaged in media-related activities such as television viewing and gaming. Psychological dimensions such as locus of control and dissociation (Murray, Fox, & Pettifer, 2007) and an individual's need to learn, need to compete, and need for activity (Seger & Potts, 2012) have been associated with engagement in virtual realities. These results provide some preliminary support for the association between personality factors and game engagement, but more research needs to be conducted on this topic. Gray's (1970) RST might provide a valuable framework to further explore the link between personality and game engagement.

The present study hypothesizes that a positive relationship will be found between the BAS system and game engagement assuming that individuals who are more sensitive to rewards will be more likely to get caught up in the virtual game environment due to their quest for rewards in the game. For BIS, on the other hand, a negative relationship is

hypothesized with game engagement given that individuals scoring high on BIS are very focused on the constant scanning of the environment for danger, making it less likely for them to get engaged and caught up in a game.

H5:Behavioral activation (BAS) is positively correlated with game engagement.
H6:Behavioral inhibition (BIS) is negatively correlated with game engagement.

Several consumer studies have hypothesized a direct relationship between media engagement, operationalized in terms of flow, and the amount of media use, mainly in online environments (e.g., Novak, Hoffman, & Yung, 2000; Webster, Trevino, & Ryan, 1993). The experience of flow is considered to be an enjoyable state, making it likely that the activity causing this flow experience will be repeated (Ghani & Deshpande, 1994), which, in turn, also can lead to habit formation (Lee & LaRose, 2007). For gaming, in particular, mixed results have been found regarding the relationship between engagement and game use. Lee and LaRose (2007) found no support for an association, while Giles and Price (2008) found a positive association between engagement and computer game use. The present study investigated whether the hypothesized relationship between BAS, on the one hand and violent and nonviolent game use, on the other hand is mediated by game engagement operationalized by the recently developed Game Engagement Questionnaire of Brockmeyer et al. (2009). As was indicated above in the rationale leading up to Hypothesis 5, a direct positive relationship can be assumed between BAS and game engagement. More specific, it can be expected that gamers who score high on reward sensitivity (BAS) will be more likely to become more engaged during game play. Game engagement might, in turn, lead to an increase in both violent and nonviolent game play. In order to come to a better understanding of the precise role of game engagement in this association, the following research question is examined:

RQ1:Game engagement mediates the relationship between BAS and violent and nonviolent game play.

METHOD

Participant Recruitment

Data were collected among a sample of 14- to 16-year-old secondary school children with different education types from 20 schools in Belgium. Schools were selected at random from the official list of secondary schools available

at the website of the Ministry of Education. A minimum sample size of 900 adolescents was needed to estimate the variance in BAS and BIS scores with a relative error of 10%, a 95% confidence interval, and an anticipated dropout of 15%. Based on the design of the study (design effect = 1.177) the minimum sample was set to 1,100 adolescents. This effect was calculated using a cluster size of 60 students per school and an intracluster correlation coefficient of 0.003, which was estimated from a pretest in five schools. An oversampling of 10% was used to guarantee the anticipated sample. The PASS software package was used to calculate sample size (Jerry Hintze, Kayville, UT, USA). Earlier experience with cross-sectional research in secondary schools indicated that the response rate of secondary schools is often low (Roberts et al., 2007), hence, schools were oversampled by 50%. Therefore, a proportionate random sample of 40 schools was selected, stratified by public and private education networks. Schools were selected using a probability proportionate to the number of pupils in the third and fourth grade. An e-mail with a recruitment letter was sent to the principals of the selected 40 schools, followed by a personal follow-up phone call a week later. In total, 20 schools confirmed their participation in the study. The principals were asked to provide the researchers with a list of all students of the third and fourth grade. A random sample of approximately 60 students per school was selected from this list. Information letters and passive informed consent forms were sent to the legal guardians of the selected adolescents. This procedure resulted in a total of 1,016 eligible adolescents between the ages of 14 and 16 years old (M = 14.73, SD = 0.72) of which 50.3% were male. The adolescents were asked to complete a pencil-and-paper survey in the classroom. Two researchers were present at all times to provide clarification when necessary. Confidentiality and anonymity were assured by the researchers both before and after the completion of the survey. Additionally, the adolescents were informed that they could stop their participation at any time.

Measures

BIS/BAS. The activity and reactivity of the BIS and BAS were assessed by the Dutch child version (Muris et al., 2005) of the BIS/BAS scale (Carver & White, 1994). The scale consists of 20 items scored on a 4-point scale ranging from *absolute disagreement* (1) to *absolute agreement* (4). In agreement with Carver and White (1994), the items are allocated to two scales: BIS scale (7 items; Cronbach's α = .74, M = 2.40, SD = 0.59) and BAS scale (13 items; Cronbach's α = .83, M = 2.41, SD = 0.51). Examples of BAS items are "I go out of my way to get things I want," "I often act on the spur of the moment," and "When good things happen to me, it affects me strongly." Examples of BIS items are "I feel worried when I think I have done poorly at something

important" and "I worry about making mistakes." The average score for both scales was calculated by summing the item scores and dividing it by the number of items. Higher scale scores are an indication of higher activity and reactivity of the system.

Game Use. A 7-point scale with response categories 0 (*(almost) never*), 1 (*a few times a year*), 2 (*about once a month*), 3 (*a few times a* month), 4 (*about once a week*), 5 (*a few times a week*), and 6 (*(almost) daily*) was used to ascertain to what extent adolescents play a variety of game genres played on a computer or console. A list of nine game genres was developed based on previous studies (Beullens, Roe, & Van Den Bulck, 2011; Tanis & Jansz, 2008; Vorderer & Bryant, 2006): action/adventure, drive 'em up, fighting, first person shooter (FPS), MMORPG, simulation, platform, horror, and party games. A principal component analysis (PCA) was conducted on the nine game genres using oblique rotation (direct oblimin). Sample adequacy was assessed by the Kaiser–Meyer–Olkin measure (KMO = .81). Furthermore, all KMO values for the individual items were between .66 and 88 and, thus, above the acceptable limit of .50. Bartlett's test of sphericity, $\chi^2(36) = 2173{,}44$ $p < .001$, showed sufficiently large correlations between the items for PCA. Two components were extracted explaining 57.47% of the variance. A good internal consistency was found for the six items of the first component (Cronbach's $\alpha = .83$). Therefore, the items (i.e., action/adventure, first person shooter, fight, drive 'em up, MMORPG, horror) were summed and divided by the number of genres to form a violent game scale with a range from 0 to 6 ($M = 1.61$, $SD = 1.49$). Also, the items of the second component (i.e., party, platform, and simulation) showed sufficient internal consistency (Cronbach's $\alpha = .63$) and were summed and divided to form a nonviolent game scale with again a range from 0 to 6 ($M = 1.25$, $SD = 1.29$). Higher scores on these scales are an indication of more frequent use of violent and nonviolent games, respectively. Normality tests showed that both for the violent and nonviolent game variable were not normally distributed as many cases were observed near the lower ends of the scale (violent games: $D(798) = 0.14$, $p < .05$ and nonviolent games: $D(798) = 0.16$, $p < .05$. Following the advice of Field (2009), this problem of nonnormality was solved, however, by using bootstrapping techniques in the data analyses as explained later.

Game Engagement. In order to assess the extent to which gamers become involved in the game and or get carried away while playing, the Game Engagement Questionnaire (GEQ; Brockmyer et al., 2009) was included in the survey. The GEQ consists of 19 items for each of which respondents had three options to indicate whether or not a certain item was applicable to them: 1(*no*), 2 (*sort of*), and 3 (*yes*). Examples of items are "I lose track of time," "I feel spaced out," and "Things seem to happen automatically." Following Brockmyer et al. (2009), all items were summed to form an index with a range from 19 to 57, which showed a good reliability in our sample

TABLE 1 Means and Standard Deviations for the Variables Studied

	Min	Max	Mean	*SD*
BIS	1	4	2.40	0.59
BAS	1	4	2.41	0.51
Violent Gaming	0	6	1.61	1.49
Nonviolent Gaming	0	6	1.25	1.29
Game Engagement	19	57	29.19	7.90

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

(Cronbach's α = .90; M = 29.19, SD = 7.90). Higher GEQ scores are an indication of higher engagement. Normality tests showed also the engagement measure was not normally distributed $D(798) = 0.11$, $p < .05$. Table 1 provides an overview of all descriptive statistics for the variables in the present study.

DATA ANALYSIS

All analyses described in the current study were conducted with IBM's SPSS 22.0. Violent game use, nonviolent game use, and game engagement were entered as dependent variables in three separate regression models using bootstrapping. The sample size of the current study is large and, according to Hayes (2013) and Field (2009), the validity of linear regression analyses should not be affected if the sample size is quite large even if the scores are not-normally distributed. Additionally, the bootstrapping method used in the analyses takes into account any problems with nonnormality (Field, 2009). For all three regression models, gender was entered in the first step as a control variable given that previous research indicated that gender differences exist regarding video game play and preferences. Studies showed, for instance, that girls game less and prefer nonviolent, traditional games (e.g., card games and arcade games) above violent and highly competitive games (e.g., fighting, race, shooter games) compared to boys (Hartmann & Klimmt, 2006; Lucas & Sherry, 2004). BAS and BIS were successively entered in step 2 given that both systems are theorized to be responsible for differences in behavior and do not always function independent from each other (Corr & McNaughton, 2008). As such, the models can examine whether RST concepts are predictors of each of the three dependent variables studied in the present research. In addition, mediation analyses were conducted using Hayes' (2013) PROCESS macro for SPSS to uncover a possible indirect pathway from BAS to violent and nonviolent game use if the regression analyses would indicate an association between this concept and game engagement. The macro uses ordinary least squares regression to estimate model parameters. Direct and indirect effects are reported as unstandardized regression coefficients in the output rendered by the PROCESS macro. The total effects model reports the explained variance

for the direct and indirect effect together. The unstandardized regression coefficients for indirect effects are calculated through a bootstrapping process determining 95% confidence intervals for the indirect effects. In the mediation models, BAS was entered as the independent predictor variable; violent and nonviolent game use as the dependent constructs in model 1 and model 2, respectively; game engagement as a mediator; and gender and BIS as control variables.

RESULTS

Descriptive Analyses

Correlation analyses (Table 2) showed no correlation between gender (boys are coded as 0, girls are coded as 1) and BAS (r_{pb} = .040, p > .05). A positive correlation was found with BIS (r_{pb} = .41, p < .01) and nonviolent gaming (r_{pb} = .033, p < .01) indicating higher BIS scores and higher levels of nonviolent games played among girls compared to boys. Results showed a negative correlation between gender and violent game use (r_{pb} = –.56, p < .01) and game engagement (r_{pb} = –.26, p < .01), which gives an indication that boys play violent games more frequently and get more engaged during game play compared to the girls in our sample. Results showed a positive correlation between BAS and violent game use (r = .16, p < .01), while a negative correlation was found between BIS and violent gaming (r = –.26, p < .01). For nonviolent game use, a positive correlation was found with both BAS (r = .13, p < .001) and BIS (r = .23, p < .01). Furthermore, the analyses indicated that a positive correlation exists between game engagement and BAS (r = .35, p < .01), but no association was found with BIS.

Regression Analyses

Violent Games. Results showed that the total model for the use of violent games is significant $F(3,799)$ = 143.90, p < .001, and explains 34.8% of the variance. Gender was a strong predictor of the use of violent games (β = –.53,

TABLE 2 Correlation Analyses for the Variables Studied

	1	2	3	4	5	6
1. Gender	–					
2. BAS	.040	–				
3. BIS	.407**	.265**	–			
4. Nonviolent Gaming	.326**	.126**	.226**	–		
5. Violent Gaming	–.560**	.155**	–.260**	.099**	–	
6. Game Engagement	–.258**	.350**	.002	.104**	.440**	–

*p < .05; **p < .01; ***p < .001.

TABLE 3 Hierarchical Regression Model for Violent Games With Bootstrapping

	B	*SE B*	β
Step 1			
Gender	–1.674	.085	–.560***
Change in R^2 = .313***			
Step 2			
Gender	–1.574	.095	–.526***
BAS	.044	.007	.197***
BIS	–.037	.012	–.100**
Change in R^2: .035*			
Final R^2 (= adjusted) = .348			
F = 143.900			
df = 3/799			

*p < .05; **p < .01; ***p < .001.

TABLE 4 Hierarchical Regression Model for Nonviolent Games With Bootstrapping

	B	*SE B*	β
Step 1			
Gender	.839	.084	.325***
Change in R^2 = .105***			
Step 2			
Gender	.746	.092	.289***
BAS	.017	.007	.086*
BIS	.025	.012	.080*
Change in R^2: .014*			
Final R^2 (= adjusted) = .119			
F = 38.919			
df = 3/840			

*p < .05; **p < .01; ***p < .001.

TABLE 5 Hierarchical Regression Model for Game Engagement

	B	*SE B*	β
Step 1			
Gender	–4.097	.517	–.260***
Change in R^2 = .066***			
Step 2			
Gender	–4.465	.530	–.283***
BAS	5.460	.488	.354***
BIS	.246	.468	.018
Change in R^2: .127***			
Final R^2 (= adjusted) = .193			
F = 70.598			
df = 3/868			

*p < .05; **p < .01; ***p < .001.

$p < .001$) with boys having a higher likelihood to play these type of game genres. In line with Hypothesis 1, BAS ($\beta = .20$, $p < .001$) was a significant positive predictor of violent gaming. Furthermore, a significant negative relationship was found between BIS and playing violent games ($\beta = -.10$, $p < .01$), which is in agreement with Hypothesis 3. Additionally, a possible interaction of gender in the associations between the BAS and BIS concepts and violent gaming was examined. The results, however, showed no significant interaction effect for the association between BAS and violent games and BIS and violent games.

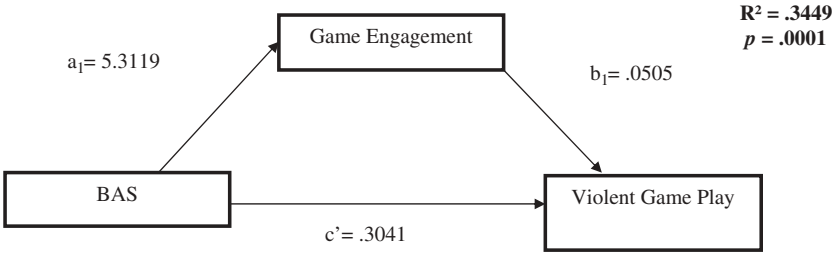
Nonviolent Games. The model was significant $F(3,840) = 38.92$, $p < .001$ and explains 11.9% of the variance. Gender was a strong predictor in the total model ($\beta = .29$, $p < .001$). Contrary to the results for violent game use, girls have a higher likelihood to play these nonviolent games compared to boys which is consistent with previous studies. As proposed in Hypothesis 2, BAS was a significant predictor of playing nonviolent games ($\beta = .09$, $p < .05$). Furthermore, Hypothesis 4 was supported with BIS being a significant positive predictor of nonviolent gaming ($\beta = .08$, $p < .05$). Again, no interaction with gender was found regarding these associations.

Game Engagement. Hierarchical regression analysis showed that the model explained 19.3% of the variance in game engagement, $F(3,868) = 70.60$, $p < .001$. Gender was a significant predictor in the total model with boys reporting higher game engagement levels ($\beta = -.28$, $p < .001$). Furthermore, BAS was a significant positive predictor ($\beta = .35$, $p < .001$) of game engagement which is in line with Hypothesis 5. The regression analysis did not provide support for the assumption made in Hypothesis 6 that BIS would be negatively associated with game engagement ($\beta = .018$, $p > .05$).

Mediation Analyses

The present study presumes that the relationship between BAS and game use might be mediated by the extent to which gamers have the tendency to get engaged in both violent and nonviolent games.

Violent Games. The results of the total effect model showed a significant total effect of BAS on violent game use (total effect coeff. = .57, $p < .001$, see Figure 1). The total variance explained by this model was 34.49% [$F(3, 791) = 138.80$, $p < .001$]. Bias-corrected bootstrap intervals for the indirect effects showed that BAS was indirectly related with playing violent games through game engagement (coeff. = .27, 95% CI: .18/.37), but also a direct effect occurred (coeff. = .30, $p < .01$). These results provided an answer to Research Question 1 and indicated that the BAS is associated with playing violent games and that this relationship is partially mediated by game engagement.

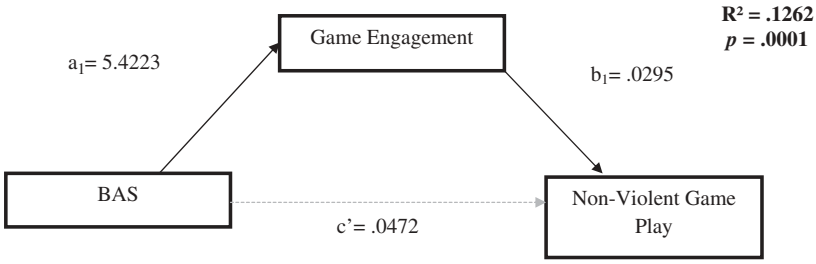


Indirect Effects	**Unstandardized Beta**	**Bootstrap SE**	**Bootstrap 95% LLCI**	**Bootstrap 95% UICI**
a_1b_1	.2683	.0483	.1823	.3674
Direct Effects	**Unstandardized Beta**	***t***	***p***	N = 795 # Bootstrap Samples = 1000
c'	.3041	3.4106	.0007	

*control variables: gender, BIS.

FIGURE 1 Mediation model of BAS and violent game play.

Nonviolent Games. The total effect model was significant for the effect of BAS on nonviolent games (total effect coeff. = .20, $p < .05$, see Figure 2). In total, this model explained 12.62% of the variance [$F(3, 832) = 40.05$, $p < .001$]. The results showed that BAS was indirectly related with



Indirect Effects	**Unstandardized Beta**	**Bootstrap SE**	**Bootstrap 95% LLCI**	**Bootstrap 95% UICI**
a_1b_1	.1599	.0354	.0966	.2321
Direct Effects	**Unstandardized Beta**	***t***	***p***	N = 836 # Bootstrap Samples = 1000
c'	.0472	0.5266	**.5986**	

*control variables: gender, BIS

FIGURE 2 Mediation model of BAS and nonviolent game play.

nonviolent game play through game engagement (coeff. = .16, 95% CI: .10/.23). A direct effect of BAS on nonviolent game use was not found (coeff. = .04, p > .05). Thus, these results indicated that the relationship between BAS and nonviolent games, as hypothesized in Hypothesis 2, only occurred indirectly by the mediation with game engagement.

DISCUSSION

The purpose of the present study was to explain game use and game engagement from a reinforcement sensitivity perspective by investigating possible associations between the BAS and BIS and game use and engagement. According to Gray's (1970) RST, behavior is the result of the activity and reactivity of these neurobiological systems which lead to differences in personality. The need for research within media studies focusing on personality has been stressed by Valkenburg and Peter (2013). Stemming from the uses and gratification perspective (Katz et al., 1973; McQuail, 2000), several studies have focused on the link between personality and media use (e.g., Andreassen et al., 2013; Chory & Goodboy, 2011; Orchard & Fullwood, 2009; Teng, 2008). Despite this need, little is known about the link between personality and media use from the perspective of RST. This theory allows us to address behavior from a neuropsychological and learning psychology perspective. This new framework might lead to new insights in media research. This article, therefore, wanted to contribute to this domain by investigating whether BAS and BIS are relevant concepts in explaining media use, and game use and game engagement, in particular, by using the adapted Dutch child version (Muris et al., 2005) of the validated BIS and BAS scales of Carver and White (1994) in a survey that was presented to a large representative sample of 1,016 Belgian adolescents.

Reinforcement Sensitivity and Game Use

The results indicated that BAS is positively associated with both violent and nonviolent gaming which is in line with our Hypotheses 1 and 2. BAS is an appetitive system that responds to the presentation of positive and rewarding signals. People with high BAS scores are very sensitive for rewarding stimuli and are therefore likely to engage in reward-oriented behavior (Corr, 2008). Also, they develop reward conditioned behavior more rapidly compared to people who are less sensitive to rewards (Pickering & Smillie, 2008). Based on the associations found with both violent and nonviolent game use, it can be hypothesized that both types of games serve as a rewarding stimulus making them an attractive pastime for reward sensitive individuals. These results are partially in line with earlier research conducted by Potter et al. (2011), who

found associations of the appetitive system with violent and competitive games (e.g., war games and fighting games), but not with traditional game genres (i.e., card games, puzzle games). The results are also in line with the findings of Koepp et al. (1998) that dopaminergic brain regions by which BAS is driven are activated during game play. Furthermore, our results indicate that BAS explains more variance of the violent gaming model than of the nonviolent gaming model. This might be explained by the higher level of competition that is usually present in violent games (Adachi & Willoughby, 2011; Carnagey & Anderson, 2005). Individuals with a high BAS are constantly in search for new rewards which might be offered to them by the heightened presence of competitive aspects in violent games compared to nonviolent games. Nevertheless, given the supported positive association between BAS and nonviolent games these games provide sufficient rewarding cues for them to be attractive to individuals with an active BAS. Based on the assumption that individuals with a highly activated BIS are more anxious and show more risk-avoidant behavior compared to individuals scoring low on BIS (Corr, 2008), we expected a negative association between BIS and violent game use (Hypothesis 3). Furthermore, a positive association was expected with nonviolent games (Hypothesis 4). Support for both Hypotheses 3 and 4 was found in the present study. BIS appeared to be a negative predictor of the use of violent games. The violence presented in these games can be regarded as an anxiety-related cue triggering avoidance behavior. Therefore, individuals with a high BIS appear to play more nonviolent games, which subject gamers to a lesser extent to anxiety-related cues such as violence, novelty and highly arousing stimuli.

Reinforcement Sensitivity and Game Engagement

The present study also aimed to explain game engagement from the perspective of the reinforcement sensitivity theory and to investigate the possible mediating role of the concept in the relationship between BAS and violent and nonviolent game use. The results supported the assumption made in Hypothesis 5 that BAS is positively associated with game engagement experienced during game play. Individuals scoring high on reward sensitivity or BAS appear to be more likely to get caught up in the virtual reality offered by a game. This is not surprising given that the higher an individual scores on reward sensitivity the more he will look for rewarding stimuli and the more he will be likely to conduct behavior that provides these rewarding cues (Pickering & Smillie, 2008). Furthermore, it was hypothesized that individuals with higher BIS scores would be less likely to get highly engaged during game play because of their need to scan the environment for possible danger and their tendency to be constantly aware of their surroundings (Gray & McNaughton, 2003). Despite these theoretical considerations, no support was found for the

existence of a negative association between BIS and game engagement. Therefore, the link between BIS and game use might be explained by another mediator such as game motivations. Finally, the present study speculated whether game engagement could serve as a mediator in explaining the association between BAS and both the use of violent and nonviolent gaming. The results showed that game engagement indeed partially mediated the relationship between BAS and violent game use and even fully mediated the relationship between BAS and nonviolent game use. The hypothesis that higher reward sensitivity is correlated with higher game engagement, which, in turn, leads to more video game play, is, therefore, supported in the present study.

Theoretical and Practical Implications

The current findings provide evidence of the value of integrating two neuropsychological concepts, more specifically BAS and BIS, in research focusing on media use. In the current study, BAS and BIS have been shown to be determinants of the use of both violent and nonviolent games and, additionally, BAS is positively associated with game engagement. The functioning of these systems, thus, appears to be related to the type of game that is played and also to the extent to which gamers get caught up in a virtual game reality during game play.

Playing games, violent games, in particular, has been linked to a variety of risk behaviors such as delinquency, risky driving, and aggressive behavior in previous studies (i.e., Beullens, Roe, & Van den Bulck, 2008; DeLisi, Vaughn, Gentile, Anderson, & Shook, 2012; Sherry, 2001). As was shown by the results of the present study, reward sensitive individuals get more engaged during game play. Therefore, it could be that they are also more sensitive to the potential (negative) effects of games on their behavior. On the other hand, if people with a higher BIS play fewer games that are violent in nature, it can be hypothesized that they will be less susceptible to this effect. The present study, therefore, argues to take into account the possible moderating role of BAS and BIS in future research on media effects as well to investigate if BAS and BIS can explain susceptibility to certain media effects.

Finally, the findings can also have value within an educational and prevention context. Commercial games have been a success for many years, but the so called “serious games” are more often being used as an educational and prevention tool. Serious games have been used, for instance, for the prevention of diabetes and obesity (Thompson et al., 2010), and to enhance traffic safety skills and knowledge (Backlund, Engstrom, Johannesson, & Lebram, 2008). Previous studies have shown that individuals with higher BAS scores are more likely to engage in several types of risk behaviors (Voigt et al., 2009), making them an important target group of serious

games. Also, for these games to have a successful outcome, it is crucial that users play the game and continue to play it for as long as is necessary. Based on our findings, it was argued that game engagement is an important determinant of playing both violent and nonviolent gaming. Serious games are mostly nonviolent given that their main purpose is not to entertain but rather to transfer a certain message. The results of the present study point out that individuals with higher scores on reward sensitivity or BAS play nonviolent games, but this relationship appeared to be fully mediated by game engagement. Therefore, in order to maximize the likelihood that people play games, developers of serious games and prevention workers need to take into account the importance of game engagement as a determinant for game play for people with a high BAS, especially given that individuals with a high BAS have been shown to be more likely to engage in risky behavior.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Despite the strengths of the study, particularly integrating BIS and BAS in research on game use and game engagement, testing mediational models, and focusing on two types of game genres, some limitations need to be addressed in future research. First, the cross-sectional design of the study does not allow for determining the temporal order of the associations nor the causality. Determining the temporal order would require a longitudinal design in which individuals are followed from the beginning of their experience with games. Such methods would allow for a better understanding of the role of BAS and BIS in the development of game preferences and the extent to which someone has the tendency to get engaged during game play. Second, research methods different from survey research can provide new and additional insights to this field of study. Given that BAS and BIS are neurobiological systems, follow-up research of Koepp et al. (1998) using brain scans can be of an added value and can provide researchers with important insights in the functioning of brain systems during the playing of different types of game genres. Also, it can be argued that the concept of game engagement cannot be fully captured using self-report measures in a questionnaire given that only the subjective and not objective game experience is assessed. Experimental research in which the objective engagement during game use is measured by taking into account eye movement and task completion time (Jennett et al., 2008) might add to the understanding of the extent to which someone gets caught up in the virtual game world while playing and might help to determine the causal order of the associations. Furthermore, it should also be noted that the internal consistency of the BIS scale only showed to be acceptable in the present study with a Cronbach's alpha of .74. This could be explained by low inter-item-correlations (mean-inter-item correlation = .29) or heterogeneity of constructs incorporated in the scale. Reliability indices of the BIS-scale

have often been found to fluctuate around .75, so our alpha .74 is consistent with this (Cooper, Gomez, & Aucote, 2007; Muris, Merckelbach, Schmidt, Gadet, & Bogie, 2001). Additionally, following Cohen's guidelines for the interpretation of alpha coefficients in the social sciences (Cohen & Swerdlik, 2010), an alpha between .70 and .80 is acceptable in survey research. Therefore, we believe that the BIS scale is a reliable tool to include in survey research conducted among adolescents. Nevertheless, future research among adolescents should be conducted to further examine the validity and consistency of the BIS scale. In sum, the results of the present study provide interesting insights on the associations between the reinforcement sensitivity theory and violent and nonviolent gaming, supporting our thesis that these concepts are very useful to introduce in media research.

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